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Serial No.: 10/762 764

In re Application of:  
Xi, et al.

Serial No.: 10/762,764

Confirmation No.: 3117

Filed: January 22, 2004

For: Method and Apparatus for Depositing Refractory Metal Layers Employing Sequential Deposition Techniques to Form a Nucleation Layer

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Group Art Unit: 2891

Examiner: David A. Zarneke

MAIL STOP APPEAL BRIEF-PATENTS  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

# APPEAL BRIEF

Applicants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 2891 dated October 17, 2005, finally rejecting claims 16-20, 23, and 26. The final rejection of claims 16-20, 23, and 26 is appealed. This Appeal Brief is believed to be timely since it is filed by the due date of March 9, 2006, as set by filing a Notice of Appeal on January 9, 2006. Authorization to charge the fee of \$500.00 for filing this brief is provided on a separate fee transmittal.

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### **Real Party in Interest**

The present application has been assigned to Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054.

### **Related Appeals and Interferences**

Applicant notes that the rejection of identical claims was previously appealed in this application (United States Patent Application Serial No. 10/762,764, filed on January 22, 2004). The previous appeal was terminated by the mailing of a new final office action on October 17, 2005, after an appeal brief was filed on August 1, 2005.

Applicant asserts that no other appeals or interferences are known to the Applicant, the Applicant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

## **Status of Claims**

Claims 16-20, 23, and 26 are pending in the application following entry by the Examiner of a Response to Final Office Action dated March 2, 2005. Claims 1-14 were originally presented in the application. Claims 8 and 10 were amended and claims 15-33 were added in the Response to Office Action dated October 7, 2004, that was filed December 21, 2004. Claims 16, 23, and 26 were amended and claims 1-15, 21, 22, 24, 25, and 27-33 were canceled in the Response to Final Office Action dated March 2, 2005, that was filed May 2, 2005. Claims 16-20, 23, and 26 stand rejected as discussed below. The rejection of claims 16-20, 23, and 26 based on the cited references is appealed. The pending claims are shown in the attached Claims Appendix.

### **Status of Amendments**

All claim amendments have been entered by the Examiner. No amendments to the claims were proposed after the final rejection dated October 17, 2005.

## Summary of Claimed Subject Matter

Embodiments of the invention provide a method of forming a refractory metal layer that includes depositing a nucleation layer on a substrate and then depositing a bulk deposition layer on the nucleation layer, wherein the bulk deposition layer includes a compound contained in one of the gases used to deposit the nucleation layer (paragraph [0010], p. 5, lines 6-11).

In the embodiment of independent claim 16, a method of forming a nucleation layer and a bulk deposition layer on a substrate having a plurality of vias (Figure 10, paragraph [0032], p. 11, lines 9-10) is provided. The refractory metal nucleation layer is formed by serially exposing the substrate to first and second reactive gases (paragraph [0028] whole paragraph and [0027], p. 9, lines 1-2). The refractory metal nucleation layer covers the plurality of vias (60 in Figure 10). A bulk deposition layer is then formed on the nucleation layer by vapor deposition (paragraph [0032], p. 11, lines 12-14). The bulk deposition layer is a refractory metal layer, *i.e.*, tungsten (paragraph [0032], p. 11, lines 12-13). The refractory metal of the bulk deposition layer is contained in one of the first and second reactive gases used to deposit the nucleation layer (paragraph [0010], p. 5, lines 6-11, paragraph [0028], lines 3-5, paragraph [0032], p. 11, lines 12-13). The bulk deposition layer fills the plurality of vias on the substrate (Figure 11, paragraph [0032], p.11, lines 16-18).

In the embodiments of independent claims 23 and 26, a method of forming a nucleation layer and a bulk deposition layer on a substrate disposed in a processing chamber is provided. The refractory metal nucleation layer is formed by serially exposing the substrate to a boron-containing compound and a tungsten-containing compound (paragraph [0028], p. 9, lines 3-5). Serially exposing the substrate to the boron-containing compound and the tungsten-containing compound includes multiple cycles (paragraph [0027], p. 9, lines 1-2) of exposing the substrate to the boron-containing compound for a period of time and exposing the substrate to the tungsten-containing compound for a period of time, such as a pulse (paragraphs [0028], p. 9, lines 9-29, Figures 12 and 13). A bulk deposition layer is then formed on the nucleation layer by employing vapor deposition to deposit a refractory metal contained in one of

the boron-containing compound and the tungsten-containing compound (paragraph [0010], p.5, lines 6-11, paragraph [0028], p. 9, lines 3-5, paragraph [0032], p. 11, line 13).



### **Grounds of Rejection to be Reviewed on Appeal**

1. Claims 16-18 and 20 stand rejected under 35 U.S.C § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700).
2. Claim 19 stands rejected under 35 U.S.C § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).
3. Claim 23 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).
4. Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).
5. Claims 16-20, 23, and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, Silicon Processing for the VLSI Era: Volume 2- Process Integration, 1990, pp. 192-194.
6. Claims 16-20, 23, and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004.
7. Claims 16-20, 23, and 26 stand provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925.

## ARGUMENTS

1. Argument with respect to the rejection of claims 16-18 and 20 under 35 U.S.C. § 103(a) by *Kang, et al.* (U.S. Patent No. 6,139,700).

**THE EXAMINER ERRED IN REJECTING CLAIMS 16-18 AND 20 UNDER 35 U.S.C. 103(a) BECAUSE *KANG, ET AL.* (U.S. PATENT NO. 6,139,700) DOES NOT TEACH OR SUGGEST BULK DEPOSITING TUNGSTEN ON A REFRACTORY METAL NUCLEATION LAYER FORMED BY SERIALY EXPOSING A SUBSTRATE TO FIRST AND SECOND REACTIVE GASES, WHEREIN TUNGSTEN IS CONTAINED IN ONE OF THE FIRST AND SECOND REACTIVE GASES.**

Claims 16-18 and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) on grounds that *Kang, et al.* teaches a method comprising forming a refractory metal nucleation layer, WN, by serially exposing the substrate to first and second reactive gases, wherein the refractory metal nucleation layer covers the via, and forming a bulk deposition layer of the refractory metal tungsten on the nucleation layer (column 6, lines 13+). The Examiner acknowledges that *Kang, et al.* fails to explicitly teach that tungsten is the bulk deposition layer filling the via and takes “official notice” that the claimed subject matter is well-known in the art, as evinced by applicant’s own admitted prior art (paragraphs [0005]-[0006] of the specification and *Chang, et al.* (U.S. Patent No. 5,028,565). The Examiner concludes “Therefore, Kang’s teaching (6, 13+) that a tungsten CVD chamber can be added to the cluster tool can be used for the bulk deposition of tungsten in to the via.” Applicants respectfully traverse the rejection.

*Kang, et al.* describes a process comprising forming a WN metal barrier layer 20 over an ohmic contact layer 16 on a substrate by atomic layer deposition using a tungsten containing precursor (column 2, line 65-column 3, line 1, column 4, lines 6-45). However, as noted by the Examiner, *Kang, et al.* does not describe bulk depositing tungsten on the WN metal barrier layer to fill a via. *Kang, et al.* teaches that the cluster tool in which the WN layer is deposited can also include an aluminum CVD chamber for

forming a subsequent metal line. *Kang, et al.* also states that the cluster tool can include a tungsten CVD chamber (column 6, lines 13-16). However, *Kang, et al.* does not teach or suggest using the tungsten CVD chamber to bulk deposit tungsten on the WN layer. Applicants note that one possible use of the tungsten CVD chamber of *Kang, et al.* is to deposit the conductive layer 16 (Figures 1A-1C, column 4, lines 9-14), which is underneath the WN barrier layer 20.

In the Advisory Action dated January 3, 2006, the Examiner states “As any and every skilled artisan would attest, the next logical step after formation of the nucleation layer would be to fill it with a bulk deposition layer, including a W layer. Therefore, the W-CVD chamber would logically be a bulk deposition layer.” Applicants agree with the Examiner’s “official notice” that the bulk deposition of tungsten in vias has been previously described. However, Applicants respectfully submit that a previous description of bulk depositing tungsten into vias and the optional presence of a tungsten CVD chamber on a cluster tool used to deposit *Kang, et al.*’s WN layer does not support finding that *Kang, et al.* actually teaches or even suggests depositing a bulk tungsten layer as part of a method including forming a nucleation layer by a serial deposition process using a first and second reactive gas, wherein one of the first and second reactive gases includes tungsten, and then bulk depositing tungsten on the nucleation layer to fill a plurality of vias. Applicants further submit that the Examiner’s assertion that “the next logical step after formation of the nucleation layer would be to fill it with a bulk deposition layer, including a W layer” does not support a finding of a suggestion or motivation to bulk deposit the specific material as claimed, *i.e.*, tungsten, on a nucleation layer deposited by serially exposing a substrate to reactive gases that include tungsten. Applicants respectfully submit that the Examiner is using hindsight to assert that bulk depositing tungsten on the WN layer of *Kang, et al.* is the next logical step, as *Kang, et al.* does not disclose or suggest depositing any material on the WN layer.

Therefore, Applicants maintain that *Kang, et al.* does not teach or suggest a method for forming a nucleation layer and a bulk deposition layer on a substrate having a plurality of vias, said method comprising forming a refractory metal nucleation layer by serially exposing said substrate to first and second reactive gases, wherein the

refractory metal nucleation layer covers the plurality of vias, and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said first and second reactive gases, wherein the bulk deposition layer fills the plurality of vias, and wherein the refractory metal is tungsten, as recited in claim 16. Applicants respectfully request withdrawal of the rejection of claim 16 and of claims 17, 18, and 20, which depend thereon.

2. **Argument with respect to the rejection of claim 19 under 35 U.S.C. § 103(a) by *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).**

**THE EXAMINER ERRED IN REJECTING CLAIM 19 UNDER 35 U.S.C. 103(a) BECAUSE *KANG, ET AL.* (U.S. PATENT NO. 6,139,700) IN VIEW OF *KANG, ET AL.* (U.S. PATENT NO. 6,287,965) DOES NOT TEACH OR SUGGEST BULK DEPOSITING TUNGSTEN ON A NUCLEATION LAYER FORMED BY SERIALY EXPOSING A SUBSTRATE TO FIRST AND SECOND REACTIVE GASES, WHEREIN TUNGSTEN IS CONTAINED IN ONE OF THE FIRST AND SECOND REACTIVE GASES AND THE FIRST REACTIVE GAS IS DIBORANE.**

Claim 19 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965) on grounds that it would have been obvious to use the WBN layer formed by atomic layer deposition in *Kang, et al.* (U.S. Patent No. 6,287,965) in place of the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), and that it would have been obvious to use a boron-containing compound to supply the boron of the WBN layer. The Examiner acknowledges that *Kang, et al.* (U.S. Patent No. 6,287,965) does not state that the B of the WBN layer is provided by diborane or any other boron-containing compound and that *Kang, et al.* (U.S. Patent No. 6,139,700) fails to teach using diborane as a reactive gas. The Examiner asserts that one would easily surmise that a boron compound would be used to supply the boron to the layer, especially in view of *Takagi, et al.* (U.S. Patent No. 6,107,200, abstract) and *Authier, et al.* (U.S. Patent No. 4,113,532, column 2, lines 29-39). Applicants respectfully traverse the rejection.

Claim 19 includes the limitations of claim 16 and further recites that the first reactive gas, which is used to deposit the refractory metal nucleation layer, is diborane. Applicants agree with the Examiner that neither *Kang, et al.* (U.S. Patent No. 6,139,700) nor *Kang, et al.* (U.S. Patent No. 6,287,965) discloses diborane. *Kang, et al.* (U.S. Patent No. 6,287,965) describes depositing metal layers having a A-B-N structure by atomic layer deposition, wherein A may be selected from a group of compounds

including tungsten, B may be selected from a group of compounds including boron, and N is nitrogen (column 2, lines 18-37). *Takagi, et al.* describes using diborane to deposit a tungsten film (abstract). *Authier, et al.* describes using diborane to deposit a metal boride layer (column 2, lines 38-39).

Applicants submit that claim 19 is patentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.* and *Authier, et al.* as *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.* individually, or in combination, do not provide or suggest all of the limitations of claim 16, which are included in claim 19. As discussed above in Argument 1 with respect to claim 16, *Kang, et al.* (U.S. Patent No. 6,139,700) does not describe or suggest bulk depositing a tungsten layer on a refractory metal nucleation layer that is formed by serially exposing a substrate to first and second reactive gases, wherein the bulk deposited tungsten layer fills vias in the substrate. Applicants further submit that the combination of *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.* does not teach or suggest bulk depositing a tungsten layer on a refractory metal nucleation layer that is formed by serially exposing a substrate to first and second reactive gases, wherein the bulk deposited tungsten layer fills vias in the substrate, and thus does not provide or suggest all of the limitations of claim 19. Applicants respectfully request withdrawal of the rejection of claim 19.

3. **Argument with respect to the rejection of claim 23 under 35 U.S.C. § 103(a) by *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).**

**THE EXAMINER ERRED IN REJECTING CLAIM 23 UNDER 35 U.S.C. 103(a) BECAUSE *KANG, ET AL.* (U.S. PATENT NO. 6,139,700) IN VIEW OF *KANG, ET AL.* (U.S. PATENT NO. 6,287,965) DOES NOT TEACH, SHOW, OR SUGGEST BULK DEPOSITING A REFRACTORY METAL ON A NUCLEATION LAYER, WHEREIN THE REFRACTORY METAL IS CONTAINED IN ONE OF A BORON-CONTAINING COMPOUND AND A TUNGSTEN-CONTAINING COMPOUND USED TO DEPOSIT THE NUCLEATION LAYER.**

Claim 23 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965) on grounds that it would have been obvious to bulk deposit tungsten on the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), use the WBN layer formed by atomic layer deposition in *Kang, et al.* (U.S. Patent No. 6,287,965) in place of the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), and use a boron-containing compound to supply the boron of the WBN layer in view of *Takagi, et al.* (U.S. Patent No. 6,107,200, abstract) and *Authier, et al.* (U.S. Patent No. 4,113,532; column 2, lines 29-39). Applicants respectfully traverse the rejection.

Claim 23 recites a method comprising forming a refractory metal nucleation layer by serially exposing said substrate to a boron-containing compound and a tungsten-containing compound, and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said boron-containing compound and tungsten-containing compound. *Kang, et al.* (U.S. Patent No. 6,139,700) describes depositing WN layers using a serial deposition and a cluster tool that may include a tungsten CVD chamber. The Examiner asserts that as the bulk deposition of tungsten is known (paragraphs [0005]-[0006] of Applicant's specification and *Chang, et al.* (U.S. Patent No. 5,028,565)), it would have been obvious

to use the tungsten CVD chamber of *Kang, et al.* (U.S. Patent No. 6,139,700) to bulk deposit tungsten on the WN layer.

Applicants respectfully submit that the combination of a previous description of the bulk deposition of tungsten (*e.g.*, *Chang, et al.*, U.S. Patent No. 5,028,565) and the description of the cluster tool of *Kang, et al.* (U.S. Patent No. 6,139,700) that may include a tungsten CVD chamber does not support a finding of a suggestion or motivation to form a refractory metal nucleation layer by serially exposing a substrate to a boron-containing compound and a tungsten-containing compound and form a bulk deposition layer on the nucleation layer using a refractory metal contained in one of the boron-containing compound and tungsten-containing compound. *Kang, et al.* (U.S. Patent No. 6,287,965) provides layers that may include boron, but does not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Applicants further submit that *Takagi, et al.* and *Authier, et al.*, individually, or in combination with *Kang, et al.* (U.S. Patent No. 6,139,700) and *Kang, et al.* (U.S. Patent No. 6,139,700) do not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Thus, *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.*, individually or in combination, do not provide or suggest all of the limitations of claim 23. Applicants respectfully request withdrawal of the rejection of claim 23.



4. **Argument with respect to the rejection of claim 26 under 35 U.S.C. § 103(a) by *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965).**

**THE EXAMINER ERRED IN REJECTING CLAIM 26 UNDER 35 U.S.C. 103(a) BECAUSE *KANG, ET AL.* (U.S. PATENT NO. 6,139,700) IN VIEW OF *KANG, ET AL.* (U.S. PATENT NO. 6,287,965) DOES NOT TEACH, SHOW, OR SUGGEST BULK DEPOSITING A REFRACTORY METAL ON A NUCLEATION LAYER, WHEREIN THE REFRACTORY METAL IS CONTAINED IN ONE OF A BORON-CONTAINING COMPOUND AND A TUNGSTEN-CONTAINING COMPOUND USED TO DEPOSIT THE NUCLEATION LAYER.**

Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965) on grounds that it would have been obvious to bulk deposit tungsten on the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), use the WBN layer formed by atomic layer deposition in *Kang, et al.* (U.S. Patent No. 6,287,965) in place of the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), and use a boron-containing compound to supply the boron of the WBN layer in view of *Takagi, et al.* (U.S. Patent No. 6,107,200, abstract) and *Authier, et al.* (U.S. Patent No. 4,113,532, column 2, lines 29-39). Applicants respectfully traverse the rejection.

Claim 26 recites a method comprising forming a refractory metal nucleation layer by serially exposing said substrate to a boron-containing compound and a tungsten-containing compound, and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said boron-containing compound and tungsten-containing compound. *Kang, et al.* (U.S. Patent No. 6,139,700) describes depositing WN layers using a serial deposition and a cluster tool that may include a tungsten CVD chamber. The Examiner asserts that as the bulk deposition of tungsten is known (paragraphs [0005]-[0006] of Applicant's specification and *Chang, et al.*, U.S. Patent No. 5,028,565), it would have been obvious

to use the tungsten CVD chamber of *Kang, et al.* (U.S. Patent No. 6,139,700) to bulk deposit tungsten on the WN layer.

Applicants respectfully submit that the combination of a previous description of the bulk deposition of tungsten (*e.g.*, *Chang, et al.* (U.S. Patent No. 5,028,565) and the description of the cluster tool of *Kang, et al.* (U.S. Patent No. 6,139,700) that may include a tungsten CVD chamber does not support a finding of a suggestion or motivation to form a refractory metal nucleation layer by serially exposing a substrate to a boron-containing compound and a tungsten-containing compound and form a bulk deposition layer on the nucleation layer using a refractory metal contained in one of the boron-containing compound and tungsten-containing compound. *Kang, et al.* (U.S. Patent No. 6,287,965) provides layers that may include boron, but does not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Applicants further submit that *Takagi, et al.* and *Authier, et al.*, individually, or in combination with *Kang, et al.* (U.S. Patent No. 6,139,700) and *Kang, et al.* (U.S. Patent No. 6,139,700) do not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Thus, *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.*, individually or in combination, do not provide or suggest all of the limitations of claim 26. Applicants respectfully request withdrawal of the rejection of claim 26.

5. Arguments with respect to the rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, Silicon Processing for the VLSI Era: Volume 2-Process Integration, 1990, pp. 192-194.

#### A. CLAIMS 16-20

THE EXAMINER ERRED IN REJECTING CLAIMS 16-20 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-4 OF U.S. PATENT NO. 6,620,723 IN VIEW OF *WOLF* BECAUSE U.S. PATENT NO. 6,620,723 IN VIEW OF *WOLF* DOES NOT TEACH OR SUGGEST BULK DEPOSITING TUNGSTEN ON A REFRACTORY METAL NUCLEATION LAYER FORMED BY SERIALY EXPOSING A SUBSTRATE TO FIRST AND SECOND REACTIVE GASES, WHEREIN TUNGSTEN IS CONTAINED IN ONE OF THE FIRST AND SECOND REACTIVE GASES.

Claims 16-20 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, Silicon Processing for the VLSI Era: Volume 2-Process Integration, 1990, pp. 192-194. The Examiner acknowledges that claims 1-4 of U.S. Patent No. 6,620,723 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

Claims 1-4 of U.S. Patent No. 6,620,723 recite a method of serially depositing boride layers using a refractory metal compound and a boron-containing compound. As noted by the Examiner, claims 1-4 of U.S. Patent No. 6,620,723 do not recite bulk depositing a layer on a nucleation layer. *Wolf* describes CVD of tungsten for interconnects, but does not teach or suggest that the CVD tungsten is deposited on a nucleation layer formed by serially exposing a substrate to first and second reactive

gases, wherein tungsten is contained in one of the first and second reactive gases. The Examiner states in the Final Office Action dated October 17, 2005, that “the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer that would have been obvious to one of ordinary skill in the art.” Applicants respectfully submit that the Examiner’s assertion that forming “a bulk deposition layer” after forming a nucleation layer would be obvious is not sufficient to support a finding that it would be obvious to deposit the specific bulk deposition material recited in the claim 16, *i.e.*, tungsten, on the specific nucleation layer recited in claims 16, *i.e.*, a nucleation layer formed by serially exposing a substrate first and second gases, wherein tungsten is contained in one of the first and second reactive gases. Applicants maintain that the Examiner has not shown a suggestion or motivation to bulk deposit tungsten on a refractory metal nucleation layer that is formed by serially exposing a substrate to first and second reactive gases, one of which includes tungsten. Applicants respectfully request withdrawal of the rejection of claims 16-20.

5. Arguments with respect to the rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, *Silicon Processing for the VLSI Era: Volume 2-Process Integration*, 1990, pp. 192-194.

#### B. CLAIMS 23 AND 26

THE EXAMINER ERRED IN REJECTING CLAIMS 23 AND 26 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-4 OF U.S. PATENT NO. 6,620,723 IN VIEW OF *WOLF* BECAUSE U.S. PATENT NO. 6,620,723 IN VIEW OF *WOLF* DOES NOT TEACH OR SUGGEST BULK DEPOSITING A REFRACTORY METAL ON A NUCLEATION LAYER, WHEREIN THE REFRACTORY METAL IS CONTAINED IN ONE OF A BORON-CONTAINING COMPOUND AND A TUNGSTEN-CONTAINING COMPOUND USED TO DEPOSIT THE NUCLEATION LAYER.

Claims 23 and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, *Silicon Processing for the VLSI Era: Volume 2-Process Integration*, 1990, pp. 192-194. The Examiner acknowledges that claims 1-4 of U.S. Patent No. 6,620,723 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

Claims 1-4 of U.S. Patent No. 6,620,723 recite a method of serially depositing boride layers using a refractory metal compound and a boron-containing compound. As noted by the Examiner, claims 1-4 of U.S. Patent No. 6,620,723 do not recite bulk depositing a layer on a nucleation layer. *Wolf* describes CVD of tungsten for interconnects, but does not teach or suggest that the CVD tungsten is deposited on a refractory metal nucleation layer formed by serially exposing a substrate to a boron-

containing compound and a tungsten-containing compound. The Examiner states in the Final Office Action dated October 17, 2005, that “the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer that would have been obvious to one of ordinary skill in the art.” Applicants respectfully submit that the Examiner’s assertion that forming “a bulk deposition layer” after forming a nucleation layer would be obvious is not sufficient to support a finding that it would be obvious to deposit the specific bulk material recited in the claims 23 and 26, *i.e.*, a refractory metal contained in one of a boron-containing compound and a tungsten-containing compound that are used to form an underlying refractory metal layer by a serial deposition process. Applicants maintain that the Examiner has not shown a suggestion or motivation to bulk deposit a refractory metal on a refractory metal nucleation layer that is formed by serially exposing a substrate to a boron-containing compound and a tungsten-containing compound, wherein the refractory metal is contained in one of the boron-containing compound and tungsten-containing compound. Applicants respectfully request withdrawal of the rejection of claims 23 and 26.

6. Arguments with respect to the rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004.

**A. CLAIMS 16-20**

**THE EXAMINER ERRED IN REJECTING CLAIMS 16-20 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-34 OF U.S. PATENT NO. 6,831,004 BECAUSE U.S. PATENT NO. 6,831,004 DOES NOT TEACH OR SUGGEST BULK DEPOSITING TUNGSTEN ON A REFRACTORY METAL NUCLEATION LAYER FORMED BY SERIALY EXPOSING A SUBSTRATE TO FIRST AND SECOND REACTIVE GASES, WHEREIN TUNGSTEN IS CONTAINED IN ONE OF THE FIRST AND SECOND REACTIVE GASES.**

Claims 16-20 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004. The Examiner acknowledges that claims 1-34 of U.S. Patent No. 6,831,004 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

Claims 1-34 of U.S. Patent No. 6,831,004 recite a method of serially depositing metal boride layers using a refractory metal compound and a boron-containing compound, but do not recite bulk depositing a layer on a nucleation layer. Applicants respectfully submit that the Examiner's assertion that forming a bulk deposition layer is an obvious next step after forming a nucleation layer is not sufficient to support a finding that it would be obvious to deposit the specific bulk deposition material recited in the claim 16, *i.e.*, tungsten, on the specific nucleation layer recited in claim 16, *i.e.*, a nucleation layer formed by serially exposing a substrate first and second gases, wherein

tungsten is contained in one of the first and second reactive gases. Applicants respectfully request withdrawal of the rejection of claims 16-20.



6. Arguments with respect to the rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004.

#### **B. CLAIMS 23 AND 26**

**THE EXAMINER ERRED IN REJECTING CLAIMS 23 AND 26 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-34 OF U.S. PATENT NO. 6,831,004 BECAUSE U.S. PATENT NO. 6,831,004 DOES NOT TEACH OR SUGGEST BULK DEPOSITING A REFRACTORY METAL ON A NUCLEATION LAYER, WHEREIN THE REFRACTORY METAL IS CONTAINED IN ONE OF A BORON-CONTAINING COMPOUND AND A TUNGSTEN-CONTAINING COMPOUND USED TO DEPOSIT THE NUCLEATION LAYER.**

Claims 23 and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004. The Examiner acknowledges that claims 1-34 of U.S. Patent No. 6,831,004 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

Claims 1-34 of U.S. Patent No. 6,831,004 recite a method of serially depositing metal boride layers using a refractory metal compound and a boron-containing compound, but do not recite bulk depositing a layer on a nucleation layer. Applicants respectfully submit that the Examiner's assertion that forming a bulk deposition layer is an obvious next step after forming a nucleation layer is not sufficient to support a finding that it would be obvious to deposit the specific bulk material recited in the claims 23 and 26, *i.e.*, a refractory metal contained in one of a boron-containing compound and a tungsten-containing compound that are used to form an underlying refractory metal

layer by a serial deposition process. Applicants respectfully request withdrawal of the rejection of claims 23 and 26.

7. Arguments with respect to the provisional rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925.

#### A. CLAIMS 16-20

THE EXAMINER ERRED IN PROVISIONALLY REJECTING CLAIMS 16-20 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-28 OF CO-PENDING U.S. PATENT APPLICATION SERIAL NO. 10/993,925 BECAUSE U.S. PATENT APPLICATION SERIAL NO. 10/993,925 DOES NOT TEACH OR SUGGEST BULK DEPOSITING TUNGSTEN ON A REFRACTORY METAL NUCLEATION LAYER FORMED BY SERIALY EXPOSING A SUBSTRATE TO FIRST AND SECOND REACTIVE GASES, WHEREIN TUNGSTEN IS CONTAINED IN ONE OF THE FIRST AND SECOND REACTIVE GASES.

Claims 16-20 stand provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925. The Examiner acknowledges that claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

Claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925 recite a method of serially depositing metal boride layers using a metal-containing compound and a boron-containing compound, but do not recite bulk depositing a layer on a nucleation layer. Applicants respectfully submit that the Examiner's assertion that forming a bulk deposition layer is an obvious next step after forming a nucleation layer is not sufficient to support a finding that it would be obvious to deposit the specific bulk

deposition material recited in the claim 16, *i.e.*, tungsten, on the specific nucleation layer recited in claims 16, *i.e.*, a nucleation layer formed by serially exposing a substrate to first and second gases, wherein tungsten is contained in one of the first and second reactive gases. Applicants respectfully request withdrawal of the provisional rejection of claims 16-20.

7. Arguments with respect to the provisional rejection of claims 16-20, 23, and 26 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925.

#### **B. CLAIMS 23 AND 26**

**THE EXAMINER ERRED IN PROVISIONALLY REJECTING CLAIMS 23 AND 26 UNDER THE JUDICIALLY CREATED DOCTRINE OF OBVIOUSNESS-TYPE DOUBLE PATENTING AS BEING UNPATENTABLE OVER CLAIMS 1-28 OF CO-PENDING U.S. PATENT APPLICATION SERIAL NO. 10/993,925 BECAUSE U.S. PATENT APPLICATION SERIAL NO. 10/993,925 DOES NOT TEACH OR SUGGEST BULK DEPOSITING A REFRACTORY METAL ON A NUCLEATION LAYER, WHEREIN THE REFRACTORY METAL IS CONTAINED IN ONE OF A BORON-CONTAINING COMPOUND AND A TUNGSTEN-CONTAINING COMPOUND USED TO DEPOSIT THE NUCLEATION LAYER.**

Claims 23 and 26 stand provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925. The Examiner acknowledges that claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925 are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add a bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

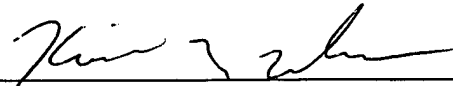
Claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925 recite a method of serially depositing metal boride layers using a metal-containing compound and a boron-containing compound, but do not recite bulk depositing a layer on a nucleation layer. Applicants respectfully submit that the Examiner's assertion that forming a bulk deposition layer is an obvious next step after forming a nucleation layer

is not sufficient to support a finding that it would be obvious to deposit the specific bulk material recited in the claims 23 and 26, *i.e.*, a refractory metal contained in one of a boron-containing compound and a tungsten-containing compound that are used to form an underlying refractory metal layer by a serial deposition process. Applicants respectfully request withdrawal of the provisional rejection of claims 23 and 26.

## CONCLUSION

For the reasons presented above, Appellants respectfully submit that the rejections of claims 16-20, 23, and 26 are improper. Reversal of the rejections is respectfully requested.

Respectfully submitted,



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## CLAIMS APPENDIX

1-15. (Canceled)

16. (Previously Presented) A method for forming a nucleation layer and a bulk deposition layer on a substrate having a plurality of vias, said method comprising:

forming a refractory metal nucleation layer by serially exposing said substrate to first and second reactive gases, wherein the refractory metal nucleation layer covers the plurality of vias; and

forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said first and second reactive gases, wherein the bulk deposition layer fills the plurality of vias, and wherein the refractory metal is tungsten.

17. (Previously Presented) The method of claim 16 wherein the bulk deposition layer is deposited employing chemical vapor deposition.

18. (Previously Presented) The method of claim 17 wherein the refractory metal nucleation layer and the bulk deposition layer are deposited in the same chamber.

19. (Previously Presented) The method of claim 16 wherein the first reactive gas is diborane ( $B_2H_6$ ).

20. (Previously Presented) The method of claim 19 wherein the second reactive gas is  $WF_6$ .

21-22. (Canceled)

23. (Previously Presented) A method for forming a nucleation layer and a bulk deposition layer on a substrate disposed in a processing chamber, said method comprising:



forming a refractory metal nucleation layer by serially exposing said substrate to a boron-containing compound and a tungsten-containing compound, wherein serially exposing said substrate to the boron-containing compound and the tungsten-containing compound comprises:

exposing said substrate to the boron-containing compound for a period of time;

exposing said substrate to a pulse of the tungsten-containing compound; and

exposing said substrate to a pulse of the boron-containing compound; and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said boron-containing compound and tungsten-containing compound.

24-25. (Canceled)

26. (Previously Presented) A method for forming a nucleation layer and a bulk deposition layer on a substrate disposed in a processing chamber, said method comprising:

forming a refractory metal nucleation layer by serially exposing said substrate to a boron-containing compound and a tungsten-containing compound, wherein serially exposing said substrate to the boron-containing compound and the tungsten-containing compound comprises:

exposing said substrate to a pulse of the boron-containing compound; exposing said substrate to a pulse of the tungsten-containing compound; and

exposing said substrate to the boron-containing compound for a period of time; and

forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said boron-containing compound and the tungsten-containing compound.

27-33. (Canceled)

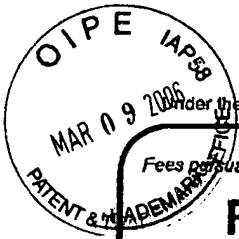
## **EVIDENCE APPENDIX**

No evidence is submitted.

## **RELATED PROCEEDINGS APPENDIX**

No copies of decisions rendered by a court or the Board in the related appeal listed on page 4 of this Brief are included as the related appeal was not forwarded to the Board.

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Effective on 12/08/2004.  
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

## FEE TRANSMITTAL for FY 2006

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$ ) 500.00

### Complete if Known

Application Number	10/762,764
Filing Date	JANUARY 22, 2004
First Named Inventor	XI, ET AL.
Examiner Name	DAVID A. ZARNEKE
Art Unit	2891
Attorney Docket No.	APPM/004714.C1/CPI/WCVD/ALD

### METHOD OF PAYMENT (check all that apply)

- ☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify) : \_\_\_\_\_
- ☒ Deposit Account Deposit Account Number: 50-1074/004714.C1/RWM Deposit Account Name: APPLIED MATERIALS, INC.
- For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)
- ☒ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, except for the filing fee
- ☐ Charge any additional fee(s) or underpayments of fee(s) ☒ Credit any overpayments
- Under 37 CFR 1.16 and 1.17

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### FEE CALCULATION

#### 1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	
Utility	300	150	500	250	200	100	_____
Design	200	100	100	50	130	65	_____
Plant	200	100	300	150	160	80	_____
Reissue	300	150	500	250	600	300	_____
Provisional	200	100	0	0	0	0	_____

#### 2. EXCESS CLAIM FEES

Fee Description		Small Entity	
		Fee (\$)	Fee (\$)
Each claim over 20 (including Reissues)		50	25
Each independent claim over 3 (including Reissues)		200	100
Multiple dependent claims		360	180
Total Claims	Extra Claims	Fee (\$)	Fee Paid (\$)
_____ -20 or HP= _____	x _____	= _____	_____
HP = highest number of total claims paid for, if greater than 20.			
Indep. Claims	Extra Claims	Fee (\$)	Fee Paid (\$)
_____ - 3 or HP= _____	x _____	= _____	_____
HP = highest number of independent claims paid for, if greater than 3.			

#### 3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
_____ - 100 = _____	/ 50 = _____	(round up to a whole number) x	= _____	_____

#### 4. OTHER FEE(S)

Non-English Specification, \$130 fee (no small entity discount)  
Other (e.g., late filing surcharge) : APPEAL BRIEF

Fees Paid (\$)

500.00

#### SUBMITTED BY

Signature		Registration No. (Attorney/Agent)	25,436	Telephone	713-623-4844
Name (Print/Type)	ROBERT W. MULCAHY	Date			

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450, DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1480, Alexandria, VA 22313-1480.

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